## What is claimed is:

[Claim 1] A method for inspection of heat exchanger tubes using reflected torsional waves, comprising the steps of:

inserting a cylindrical waveguide probe into an open end of a heat exchanger tube, a coupled end of the waveguide probe being located a distance from the open end by at least the distance from the open end to a heat exchanger tube sheet;

applying an electronic transmit pulse to a magnetostrictive sensor mounted on the waveguide probe;

generating and transmitting a torsional wave pulse in the waveguide probe by the magnetostrictive sensor;

coupling the transmitted torsional wave from the waveguide probe to an inside wall of the heat exchanger tube for propagation along the length of the heat exchanger tube;

coupling reflected torsional wave signals from defects and a far end of the heat exchanger tube to the waveguide probe;

sensing the reflected torsional wave signals by a magnetostrictive sensor; and

electronically processing the sensed signals for determining a location and characteristics of the defects in the heat exchanger tube walls.

[Claim 2] The method of claim 1, wherein the step of generating a torsional wave pulse and the step of sensing the reflected torsional wave signals are performed by the same magnetostrictive sensor including an integrated magnetostrictive transmitter and receiver.

[Claim 3] The method of claim 1, wherein the step of generating a torsional wave pulse and the step of sensing the reflected torsional wave signals are performed by separate magnetostrictive sensors including a magnetostrictive transmitter and separate magnetostrictive receiver.

[Claim 4] The method of claim 1, wherein the step of generating torsional waves comprises applying an electric current pulse of a fixed frequency to a

coil wound over a ferromagnetic strip of the magnetostrictive sensor cylindrically affixed on the cylindrical waveguide probe.

[Claim 5] The method of claim 4, wherein the ferromagnetic strip is selected from the group consisting of a nickel strip and a strip of material having good magnetostrictive properties.

[Claim 6] The method of claim 4, further comprising the step of magnetically polarizing the ferromagnetic strip in a circumferential direction.

[Claim 7] The method of claim 1, wherein the step of coupling the torsional waves between the waveguide tube and the heat exchanger tube comprises expanding the coupled end of the waveguide tube to make intimate contact between the coupled end and the inside diameter of the heat exchanger tube by applying a force from inside the waveguide tube using an expansible device.

[Claim 8] The method of claim 1:

wherein the step of applying an electronic transmit pulse comprises activating a function generator by an output of a control processor for generating a transmit pulse, connecting the transmit pulse at an output of the function generator to a power amplifier input for amplifying the transmit pulse, and applying the amplified output pulse from the output of the power amplifier to the magnetostrictive sensor;

wherein the step of electronically processing the reflected torsional waves comprises amplifying a signal from the magnetostrictive sensor in a preamplifier, connecting the amplified signal at an output of the preamplifier to an input of an analog-to-digital converter, and connecting an output of the analog-to-digital converter to an input of the control processor; and

further comprising the step of determining locations and characteristics of defects in the heat exchanger tube walls by the control processor using signal characteristics from the analog-to-digital converter output and the time differences between applying the electronic transmit pulse and sensing of the signal characteristics from the analog-to-digital converter output.

[Claim 9] A system for inspection of heat exchanger tubes using reflected torsional waves, comprising:

a cylindrical waveguide probe inserted into an open end of a heat exchanger tube, a coupled end of the waveguide probe being located a distance from the open end by at least the distance from the open end to a heat exchanger tube sheet;

means for applying an electronic transmit pulse to a magnetostrictive sensor mounted on the waveguide probe;

means for generating and transmitting a torsional wave pulse in the waveguide probe by the magnetostrictive sensor;

means for coupling the transmitted torsional waves from the waveguide probe to an inside wall of the heat exchanger tube for propagation along the length of the heat exchanger tube;

means for coupling reflected torsional wave signals from defects and a far end of the heat exchanger tube to the waveguide probe;

means for sensing the reflected torsional wave signals by a magnetostrictive sensor; and

means for electronically processing the sensed signals for determining a location and characteristics of the defects in the heat exchanger tube walls.

[Claim 10] The system of claim 9, wherein the means for applying an electronic transmit pulse comprises:

a control processor for activating a function generator to produce an output pulse;

a power amplifier for amplifying the output pulse to provide an electronic transmit pulse; and

the electronic transmit pulse being connected to the magnetostrictive sensor.

[Claim 11] The system of claim 9, wherein the means for generating a torsional wave pulse and the means for sensing the reflected torsional wave signals are performed by the same magnetostrictive sensor including an integrated magnetostrictive transmitter and receiver.

[Claim 12] The system of claim 9, wherein the means for generating a torsional wave pulse and the means for sensing the reflected torsional wave signals are performed by separate magnetostrictive sensors including a magnetostrictive transmitter and separate magnetostrictive receiver.

[Claim 13] The method of claim 9, wherein the means for generating torsional waves comprises means for applying an electric current pulse of a fixed frequency to a coil wound over a ferromagnetic strip of the magnetostrictive sensor cylindrically affixed on the cylindrical waveguide probe.

[Claim 14] The system of claim 13, wherein the ferromagnetic strip is selected from the group consisting of a nickel strip and a strip of material having good magnetostrictive properties.

[Claim 15] The system of claim 13, further comprising means for magnetically polarizing the ferromagnetic strip in a circumferential direction.

[Claim 16] The system of claim 9, wherein the means for coupling the torsional waves between the waveguide tube and the heat exchanger tube comprises expanding the coupled end of the waveguide tube to make intimate contact between the coupled end and the inside diameter of the heat exchanger tube by applying a force from inside the waveguide tube using an expansible device.

[Claim 17] The system of claim 9, wherein the means for coupling the torsional waves between the waveguide tube and the heat exchanger tube comprises:

a drawbar mechanism being repositioned for actuating an expanding collet on the coupled end of the waveguide probe, the actuated expanding collet for expanding the coupled end of the waveguide probe to create a firm mechanical contact with the inside wall of the heat exchanger tube;

the generated transmitted torsional wave being propagated from the magnetostrictive sensor to the coupled end of the waveguide probe; and

the propagated torsional wave being coupled from the coupled end of the waveguide probe to the inside wall of the heat exchanger tube.

[Claim 18] The system of claim 17, wherein the means for coupling reflected torsional wave signals comprises:

the reflected torsional wave signals being coupled from the inside wall of the heat exchanger tube to the coupled end of the waveguide probe; and

the reflected torsional wave signals being propagated from the coupled end of the waveguide probe to the magnetostrictive sensor.

[Claim 19] The system of claim 9:

wherein the means for applying an electronic transmit pulse comprises a function generator being activated by an output of a control processor for generating a transmit pulse, the transmit pulse at an output of the function generator being connected to a power amplifier input for amplifying the transmit pulse, and the amplified output pulse from an output of the power amplifier being applied to the magnetostrictive sensor;

wherein the means for electronically processing the reflected torsional waves comprises a signal from the magnetostrictive sensor being amplified in a preamplifier, the amplified signal at an output of the preamplifier being connected to an input of an analog-to-digital converter, and an output of the analog-to-digital converter being connected to an input of the control processor; and

further comprising locations and characteristics of defects in the heat exchanger tube walls being determined by the control processor using signal characteristics from the analog-to-digital converter output and the time differences between applying the electronic transmit pulse and sensing the signal characteristics from the analog-to-digital converter output.

[Claim 20] A method for inspection of heat exchanger tubes using reflected torsional waves, comprising:

generating, transmitting and coupling a torsional wave pulse to an inside wall of a heat exchanger tube for propagation along the length of the heat exchanger tube;

coupling and sensing reflected torsional wave signals from defects and a far end of the heat exchanger tube; and

electronically processing the transmitted and sensed torsional waves for determining defect location and characteristics.